Potential Maui Electric and Hawaii Natural Energy Institute Molokai Battery Project

Informational Meeting
November 7, 2013

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Agenda

- Background
- Electrical grid risks
- Potential solutions
- Battery System Information
- Timeline
Definitions

- Grid
  - The electrical system that services the entire island of Molokai.

- Circuit
  - A part of the electrical system that delivers power to customers from the power station and serves a small geographic area that can be as small as a neighborhood.

- Distributed Generation (DG)
  - Equipment that produces electricity on a circuit. Basically any electrical generation on Moloka‘i that does not come from the utility power plant.

- Photovoltaic (PV) System
  - Most common type of DG – usually installed on a residential or commercial rooftop to offset electrical consumption.
Molokai Electrical Grid

- Peak Load: 5.4 MW (2013)
- Minimum Load: 2.1 MW (daytime, 2013)
- PV Installed: 1.07 MW (with 59.3Hz drop-out)
- PV Planned: 0.36 MW (with 57Hz drop-out)
- Three 2,200 kW diesel generators
- One 2,220 kW gas turbine
- Six smaller (1 MW) diesel generators
- Five major 12kV feeders & 34.7kV “transmission”
- Approximately 2000 customers

Almost one third of the daytime minimum load can be met by the installed PV, more already committed
Electrical Grid Risks

- All utilities are subject to unplanned events such as loss of generation.
- The impact of these events is more significant on smaller, isolated grids.
- Most events can be managed by adjusting other generation resources.
- If event is more significant, customer loads are disconnected automatically, reducing power demand, to try to maintain operation.
- While events can happen at any time of the day, significant events during the daytime can cause all PV on the island to stop operating, increasing the risks on the entire grid.

The increase in PV generation has increased the need for new solutions to reduce the impact of loss of generation.
Molokai PV Situation

- Current distributed generation screening (as described in PUC Rule 14) only addresses circuit-related risks of PV.
- Kaunakakai Circuit study found that distributed PV on Molokai presented a risk to entire grid, not just circuit
- Potential risk confirmed by follow-up study

Risks on the electric grid as a whole are not assessed in the screening process.
PV Shutting Off – *See Animated Slides*
Potential Solutions

- Turn on more Maui Electric generators
  - More generators to help replace the generation that is lost – provided they can respond quick enough
  - Reduces, but may not eliminate, load shedding
  - The additional generators must be running more often and always during times when PV may turn off
  - Molokai electrical usage can be the lowest during the day, when PV production is high, which makes turning more units on difficult

Increases fossil fuel use and cost to ratepayer
Potential Solutions

- Smart Grid Technology
  - Distributed Batteries
    - New and still in development
    - Still involves significant costs
  - Distributed Load Control
    - Response is less predictable
    - Still involves load shedding, but more selective
  - Requires system wide communication system
  - Does not take up space on the grid when not needed

Smart Grid Solutions are still largely experimental
Potential Solutions

- Install a Battery
  - Quick to respond
  - Modular battery units can be replaced when needed over time.
  - Can be sized to eliminate most if not all load shedding and improve power quality
  - Does not take up room on the system when not needed
  - Can be implemented relatively quickly
  - External funding is available
Battery Energy System (BESS)
Altairnano Li-ion Titanate

- Power module produces 2 MW
- Capacity of 375 kW-Hr
- Inverter rated > 2 MVAr
- Over 12,000 full charge / discharge cycles with minimal degradation in cell capacity

Interior View
- Li-Ion Titanate 50 A-Hr Cells
- 2MW BESS has 2688 cells in 96 LRU

Designed for rapid charging and discharging
Battery Installation
Cost and Ownership

- **Cost**
  - Battery paid for by HNEI ~$1.8 million
  - Interconnection paid for by MECO ~$1.3 million
  - Cost to be spread over all Maui County Customers

- **Who will own the BESS?**
  - Altairnano until it is installed, commissioned and accepted.
  - UH/HNEI after acceptance
  - HNEI will transfer ownership to Maui Electric under MOA that allows HNEI access to battery and grid data for study (3 to 5 years)
  - HNEI will maintain full warranty on battery for the duration of HNEI study

Average bill impact is estimated to be less than 25 cents per month
Battery Replacing Generation
PV Staying on

Generator
PV
Generator
Customers
Customers
Battery Replacing Generation
PV Staying on – See Animated Slides
PV & Load Variation – See Animated Slides
Timeline

◆ When will the installation occur?
  – If the project is to proceed, it is anticipated to be operational in the summer of 2014.
◆ During the study period?
  – Maui Electric will own the BESS
  – HNEI will collect data and maintain warranty for duration of study following the demonstration project
◆ After the study period
  – Maui Electric will own and maintain the BESS
Mahalo for your time!
June 13  Unit 8 Tripped on 7:36 AM, UFLS activated

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- 45 cycle delay
- 30 cycle delay
- 10 cycle delay
Figure 1 System Frequency Response for the Loss of the Largest Diesel Generator at Palaau Power Plant
How will the BESS be used

- High-power, rapid response to replace utility loss generation (minimize need for load shed)
- Rapid cycling between charging and discharging to reduce frequency variability due to changes in variable generation and load
- Standby capacity to serve as spinning reserve (possible)
- Voltage support (possible)
Example of BESS for Frequency Regulation

Battery cycled on and off in twenty minute intervals

- 1MW fast battery reduces variability of the grid frequency with wind and solar on grid

Battery Output: 1MW

Grid Frequency (Hz):
- with battery off (black) and on (red) at 20 minute intervals

1MW fast battery reduces variability of the grid frequency with wind and solar on grid

Hawaiian Electric
Maui Electric
Hawai‘i Electric Light

HNEI
Hawai‘i Natural Energy Institute
University of Hawai‘i at Mānoa
Big Island Frequency Change with loss of ~ 1MW of wind

- A – ~1MW drop in wind power wo battery active
- B – drop in grid frequency correlated to loss of wind wo battery active
- C – similar change in wind power with BESS on
- D – reduced response in grid frequency to loss of wind with BESS on
- E – BESS discharge in response to frequency change (~ 800kW)

BESS appears to Reduces Frequency Change with Wind Event